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ON HETEROCATALYTIC DETONATIONS I. (U)

Hydrodynamic Lenses and Radiation Mirrors

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ON HETEROCATALYTIC DETONATIONS I.

Hydrodynamic Lenses and Radiation Mirrors

Introduction

In this discussion the following general scheme is considered. By an explosion of one or several conventional auxiliary fission bombs, one hopes to establish conditions for the explosion of a "principal" bomb. This latter may be either a fission or a thermonuclear assembly.

We propose to discuss certain general features of such an arrangement. The main purpose of the "auxiliary" system is to induce very high compressions in the principal assembly. It is known (L. W. Nordheim, unpublished data) that, for example, in the "Alarm Clock" high compressions of the active core will permit economy in the tritium put initially into the system and may be instrumental in starting thermonuclear reactions in assemblies of a feasible size. Ordinarily one uses high explosives as the auxiliary system. Great compression can be obtained, but the size of the highly compressed region is small. In certain thermonuclear arrangements, like the Alarm Clock, the size and the mass of the material to be compressed is so great that inordinate amounts of HE would have to be used. We have the following situation in mind, as an example.

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We shall discuss in the sequel the hoped-for compressions.

The arrangement might be called heterocatalytic, involving as it does a setting off of a reaction in one system by a reaction started in another material--the "auxiliary" arrangement is located at a considerable distance (from the purely nuclear point of view), like 50 cm to 5 meters. This is in distinction to hitherto-considered autocatalytic schemes based essentially on self-implosions of a mixture of nuclear substances.

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The difference of sound velocities is due to three reasons. One is the difference in average atomic weights, due primarily to the different degrees of ionization. Thus a light element like carbon would be almost completely ionized and would behave like a gas of approximate atomic weight 2. Uranium, on the other hand, would suffer approximately 10-fold ionization and would have an effective atomic weight near 8. The ratio four in atomic weights would give rise to a factor two in sound velocities. The higher velocity is of course to be expected in carbon.

A second reason for a difference in sound velocities is the fact that a completely ionized material acts like a monatomic gas with $\gamma = \frac{5}{3}$, whereas uranium, in which ionization is still proceeding, has probably a γ-value near 1.4. This will increase the ratio of sound velocities by another 10%.

The third reason is that the same shock strength will produce a lower temperature in a material of higher density since in each material the given energy density is distributed among more particles. This effect might give rise to temperature ratios as high as a factor four and to sound velocity ratios as high as a factor two. (In principle this effect could be made even greater but one would soon begin to lose by poor matching of acoustic impedance.)

It is, therefore, reasonable to assume that materials can be found in which sound velocities differ by a factor somewhere between 2 and 4. There should be no difficulty in making materials of any intermediate sound velocity.

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FIGURE 1

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FIGURE 2

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FIGURE 3

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FIGURE 4

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In fact, the essential parts of the design do not depend sensitively on complicated shapes and the necessary planning is, therefore, comparatively simple.

The proposals are outlined here extremely sketchily. Quantitative work to elaborate these general suggestions would have to include the following calculations:

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